

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

12/2004



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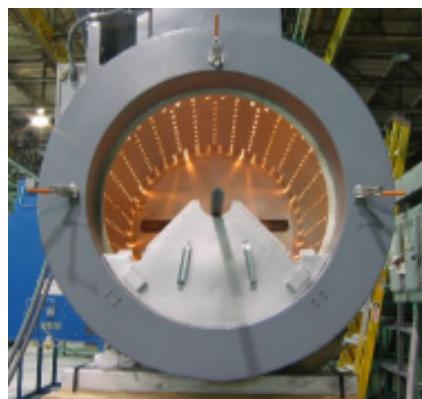
STRATEGIES FOR CONTROLLING COAL PERMEABILITY IN CO₂-ENHANCED COALBED METHANE RECOVERY

Background

Evidence is mounting that rising levels of atmospheric CO₂, caused primarily by combustion of fossil fuels, are leading to global warming. To address this problem, many nations are developing plans for decreasing CO₂ emissions to the atmosphere. The principal approaches under consideration are improving energy efficiency, making greater use of non-fossil energy sources, and creating economically viable technologies for capture and long-term storage of CO₂. The latter strategy, commonly known as CO₂ sequestration, will keep a large quantity of CO₂ out of the Earth's atmosphere for hundreds to thousands of years. Consequently, it permits continued use of high-carbon fossil fuels to generate electrical power while ensuring that CO₂ releases to the atmosphere are reduced.

A potentially attractive means for geologic CO₂ sequestration is injection of CO₂ into underground reservoirs. The primary candidates are active or depleted oil and gas fields, deep brine formations, and unmineable coalbeds. To date, studies to determine the feasibility of geologic CO₂ sequestration have focused on oil and gas fields and deep brine formations. However, four characteristics of deep unmineable coalbeds make them extremely attractive for wide-scale CO₂ sequestration:

1. Unmineable coal seams are widely distributed across the U.S.
2. When CO₂ is injected into a coalbed, it efficiently displaces adsorbed methane (CH₄). Therefore, CO₂ sequestration and coalbed methane (CBM) production are synergistic technologies, with the extra natural gas produced serving to offset some of the costs of CO₂ injection.
3. After injection, CO₂ remains tightly bound to coal surfaces; therefore, there is little risk that, over time, it will leak to overlying strata or to the surface. This is an enormous advantage over CO₂ storage in deep saline formations, where escape of gas through caprock is a potentially serious problem.
4. Many unmineable coal seams are located near coal-fired power plants, which are large point sources of CO₂. Thus, minimal pipeline transport would be required to deliver CO₂ to a suitable site for injection.



Endview of a 30-inch I.D., infrared forced-air convection oven custom designed and constructed for heating powdered and solid coal samples to temperatures attained in deep unmineable coalbeds.



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PARTNERS

Oak Ridge National Laboratory
(ORNL)

COST

Total Project Value
\$600,000

DOE/Non-DOE Share
\$600,000/\$0

Benefits

If CO₂ emissions into the atmosphere from fossil fuel-fired power plants are to be controlled, suitable technologies for sequestering CO₂ must be developed. One very promising technique is CO₂-ECBM production. However, for this approach to be successfully pursued, much more information is needed on the behavior of coalbeds during and after CO₂ injection. This project will develop much of the needed data required to model CO₂-ECBM. These modeling efforts, along with demonstration programs, will establish the feasibility of CO₂-ECBM and the amount of natural gas that can be produced from such projects.

CBM recovery, accomplished principally by pumping formation water out of coalbeds, is a mature technology. In contrast, CO₂-enhanced CBM (CO₂-ECBM) recovery is a recent concept that has been demonstrated at only a few field sites. Therefore, vigorous fundamental and applied research programs are needed to fill major knowledge gaps.

Brought to full fruition, CO₂-ECBM could become a leading technology for combined CO₂ sequestration and enhanced methane recovery. However, to enable reliable numerical modeling of CO₂-ECBM production, the effects of CO₂ injection rate, formation temperature, total gas pressure, and gas composition on coal swelling and shrinkage, and sorption/desorption of gases on coal surfaces, must be known quantitatively. The impacts of these effects cannot be predicted accurately by current methods of reservoir modeling and simulation; consequently, an experimental program is needed to obtain the required information.

Due to their special importance, this project is particularly concerned with factors that affect coal permeability when CO₂ is injected into a subsurface coalbed. The major permeability-affecting parameters are likely to be: initial coal porosity and permeability; formation temperature; the rate of CO₂ injection; time-dependent local gas composition, including moisture content; and the characteristics of the organic and inorganic surfaces of the coal into which mixed CO₂-CH₄-H₂O gas penetrates. The results of CO₂ influx will include sorption/desorption of gas species, coal swelling and shrinkage, migration of CH₄ toward production wells and other regions of lower gas pressure, and drying of the coal near the point of CO₂ injection. These effects will have time varying, interacting impacts on coal permeability. Therefore, sorting out the individual and collective effects of factors that affect coal permeability during CO₂-ECBM operations is absolutely essential for reliable prediction and full optimization of CO₂ sequestration in, and enhanced methane recovery from, subsurface coalbeds.

Primary Project Goal

The primary goal is to acquire the critically important technical information needed to assess the feasibility of sequestering CO₂ in deep unmineable coalbeds.

Objectives

- To acquire and characterize sections of coal core obtained from the Black Warrior Basin in westcentral Alabama.
- To complete a set of sorption/desorption experiments on powdered coal samples from the Black Warrior Basin.
- To complete a set of gas permeability experiments on uncrushed coal samples from the Black Warrior Basin to determine the effects of: (1) the rate of CO₂ injection; (2) adsorption of CO₂ onto, and desorption of CH₄ and H₂O from, coal surfaces; (3) coal swelling and shrinkage due to gas adsorption and desorption; and (4) drying of moist coal near the site of CO₂ injection.

Accomplishments

Unique, custom-designed laboratory facilities have been constructed to measure the densities of mixed CO₂-CH₄ gases at 20-50°C, 0-2000 psi, and to determine the factors that have the greatest influence on subsurface coal permeability during CO₂-ECBM operations. The measurements being made with the new equipment are addressing critical information needs for current and future U.S. CO₂-ECBM demonstration sites.